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Document Name: SAE J429: Mechanical and Quality Requirements for Externally Threaded Fasteners

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MECHANICAL AND QUALITY REQUIREMENTS FOR EXTERNALLY THREADED FASTENERS — SAE J429f

SAE Standard

Report of Iron and Steel Technical Committee approved January 1949 and last revised June 1971.

1. Scope—This SAE Standard covers the mechanical and quality requirements for steel bolts, screws, studs, and sems used in automotive and related industries in sizes to 1½ in, inclusive. This standard does *not* include limits for surface discontinuities. Where usage requires such control, limits may be specified separately. For certain type, size, and length of products this may be done by the statement: "Surface discontinuities shall not exceed the limits shown in SAE J123."

NOTE: Previous issues of this standard also covered nuts, now covered separately in SAE J995.

2. Designations

2.1 Designation System—Grades are designated by numbers where increasing numbers represent increasing tensile strength, and by decimals of whole numbers where decimals represent variations at the same strength level. The grade designations are given in Table 1.

2.2 Grades—Bolts and screws are normally available only in Grades 1, 2, 5, 5.2, 7, and 8. Studs are normally available only in Grades 1, 2, 4, 5, 8, and 8.1. Grade 5.1 is applicable to sems which are heat treated following assembly of the washer on the screw, and to products without assembled washer.

3. Materials and Processes

3.1 Steel Characteristics—Bolts, screws, studs, and sems shall be made of steel conforming to the description and chemical composition requirements specified in Table 2 for the applicable grade.

3.2 Heading Practice—Methods other than upsetting and/or extrusion are permitted only by special agreement between purchaser and supplier.

Grade 1 bolts and screws may be hot or cold headed, at option of the manufacturer.

Grades 2, 5, 5.2, 7, and 8 bolts and screws in sizes up to ¾ in, inclusive, and in lengths up to 6 in, inclusive, shall be cold headed, except that by special agreement they may be hot headed. Larger sizes and longer lengths may be hot or cold headed, at option of the manufacturer.

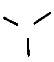
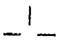
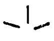
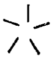
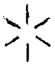
Grade 5.1 bolts, screws, and sems shall be cold headed.

3.3 Threading Practice—Grades 2, 5, 5.2, and 8 bolts and screws in sizes up to ¾ in, inclusive, and lengths up to 6 in, inclusive, shall be roll threaded, except by special agreement. Grade 7 bolts and screws shall be roll threaded after heat treatment. Grade 5.1 bolts, screws, and sems shall be roll threaded. Threads of all sizes of Grade 1 bolts and screws, and Grades 2, 5, 5.2, and 8 bolts and screws in sizes over ¾ in and/or lengths longer than 6 in, may be rolled, cut, or ground, at option of the manufacturer. Threads of all grades and sizes of studs may be rolled, cut, or ground, at option of the manufacturer.

3.4 Heat Treatment Practice—Grade 1 bolts and screws and Grades 1 and 2 studs need not be heat treated. When specified by purchaser, Grade 2 cold headed bolts and screws shall be stress relieved at a minimum stress relief temperature of 875 F (468 C). Grades 4 and 8.1 studs are manufactured from pretreated material and the studs, as manufactured, need no further heat treatment. Grades 5 and 5.2 bolts, screws, and studs shall be heat treated, oil or water quenched, at option of manufacturer, and tempered at a minimum tempering temperature of 800 F (427 C). Grade 5.1 bolts, screws, and sems shall be heat treated, quenched, and tempered at a minimum tempering temperature of 650 F (343 C). For Grade 5.1 sems, quenchants whose principal constituent is water shall not be used, unless specifically approved by the user. Grades 7 and 8 bolts and screws and Grade 8 studs shall be heat treated, oil quenched, and tempered at a minimum tempering temperature of 800 F (427 C).

3.5 Decarburization—Unless otherwise specified, Grades 5, 5.1, 5.2, 7, and 8 bolts, screws, and studs shall conform to Class C unless Class B is specified, as described in SAE J121.

TABLE 1—MECHANICAL REQUIREMENTS AND IDENTIFICATION MARKING FOR BOLTS, SCREWS, STUDS AND SEMS

Grade Designation	Products	Nominal Size Dia, in	Full Size Bolts, Screws, Studs, Sems		Machine Test Specimens of Bolts, Screws, and Studs				Surface Hardness	Core Hardness		Grade Identification Marking
			Proof Load, psi	Tensile Strength Min, psi	Yield[a] Strength Min, psi	Tensile Strength Min, psi	Elongation[f] Min, %	Reduction of Area Min, %	Rockwell 30N Max	Rockwell Min	Rockwell Max	
1	Bolts, Screws, Studs	1/4 thru 1-1/2	33,000	60,000	36,000[b]	60,000	18	35	—	B70	B100	None
2	Bolts, Screws, Studs	1/4 thru 3/4[c]	55,000	74,000	57,000	74,000	18	35	—	B80	B100	
		Over 3/4 to 1-1/2	33,000	60,000	36,000[b]	60,000	18	35	—	B70	B100	None
4	Studs	1/4 thru 1-1/2	—	115,000	100,000	115,000	10	35	—	C22	C32	None
5	Bolts, Screws, Studs	1/4 thru 1	85,000	120,000	92,000	120,000	14	35	54	C25	C34	 Bolts and Screws only
		Over 1 to 1-1/2	74,000	105,000	81,000	105,000	14	35	50	C19	C30	
5.1[d]	Bolts, Screws, Sems[h]	No. 6 thru 3/8	85,000	120,000	—	—	—	—	59.5[g]	C23	C40[g]	 Hex head sems only
5.2	Bolts Screws	1/4 thru 1	85,000	120,000	92,000	120,000	14	35	56	C26	C36	 Bolts and Screws Only
7[e]	Bolts Screws	1/4 thru 1-1/2	105,000	133,000	115,000	133,000	12	35	54	C28	C34	 Bolts and screws only
8	Bolts, Screws, Studs	1/4 thru 1-1/2	120,000	150,000	130,000	150,000	12	35	57.5	C32	C38	 Bolts and screws only
8.1	Studs	1/4 thru 1-1/2	120,000	150,000	130,000	150,000	10	35	—	C32	C38	None
8.2	Bolts Screws	1/4 thru 1-1/2	←See Appendix→									

[a] Yield strength is stress at which a permanent set of 0.2% of gage length occurs.

[b] Yield point shall apply instead of yield strength at 0.2% offset.

[c] Grade 2 requirements for sizes 1/4 through 3/4 in apply only to bolts and screws 6 in and shorter in length, and to studs of all lengths. For bolts and screws longer than 6 in, Grade 1 requirements shall apply.

[d] Grade 5 material heat treated before assembly with a hardened washer is an acceptable substitute.

[e] Grade 7 bolts and screws are roll threaded after heat treatment.

[f] See Table 6 for gage length.

[g] Hex washer head and hex flange products without assembled washers shall have a core hardness not exceeding Rockwell C38 and a surface hardness not exceeding Rockwell 30N 57.5.

[h] Sems-screw and washer assemblies.

TABLE 2—CHEMICAL COMPOSITION REQUIREMENTS[a]

Grade	Material and Treatment	Element, %					
		C Min	C Max	Mn Min	P Max	S Max	B Min
1	Low or medium carbon steel	—	0.55	—	0.048	0.058	—
2	Low or medium carbon steel	—	0.28[b]	—	0.048	0.058[c]	—
4	Medium carbon cold drawn steel	—	0.55	—	0.048	0.058	—
5	Medium carbon steel, quenched and tempered	0.28	0.55	—	0.048	0.058[d]	—
5.1	Low or medium carbon steel, quenched and tempered	0.15	0.30	—	0.048	0.058	—
5.2	Low carbon martensite steel, fully killed, fine grain, quenched and tempered	0.15	0.25	0.74	0.048	0.058	0.0005
7	Medium carbon alloy steel, quenched and tempered[e]	0.28	0.55	—	0.040	0.045	—
8	Medium carbon alloy steel, quenched and tempered[e]	0.28	0.55	—	0.040	0.045	—
8.1	Elevated temperature drawn steel—medium carbon alloy or SAE 1541 (formerly SAE 1041)	0.28	0.55	—	0.048	0.058	—
8.2	Low carbon martensite steel, fully killed, fine grain, quenched and tempered	←See Appendix→					

[a] All values are for check analysis (per cent by weight). For ladle analysis, use standard permissible variations as shown in SAE J409.

[b] For all sizes and lengths of studs, and for bolts and screws larger than 3/4 in diameter and/or longer than 6 in, carbon content may be 0.55% max.

[c] For studs only, sulfur content may be 0.33% max.

[d] For studs only, sulfur content may be 0.13% max.

[e] Steel shall be fine grain, with hardenability that will produce a minimum hardness of Rockwell C47 at the center of the threaded section one diameter from the end of the bolt, screw, or stud after oil quenching (see SAE J407). Carbon steel may be used by agreement between producer and consumer, for sizes 1/4 through 3/4 in diameter products. SAE 1541 (1041) steel, oil quenched and tempered, may be used at the option of the producer for products 7/16 in nominal diameter and smaller.

4. *Mechanical Requirements*—Bolts, screws, studs, and sems shall be tested in accordance with the mechanical testing requirements for the applicable type, grade, size, and length of product as specified in Table 3, and shall meet the mechanical requirements specified for that product in Table 1.

5. *Methods of Test*

5.1 Hardness—The hardness of bolts, screws, studs, and sems shall be determined at mid-radius of a transverse section through the threaded portion of the product taken at a distance of one diameter from the end of the product. The reported hardness shall be the average of four hardness readings located at 90 deg to one another. The preparation of test specimens and the performance of hardness tests shall be in conformity with the requirements of SAE J417.

To meet the requirements of paragraph 4, the hardness shall not exceed the maximum hardness specified in Table 1 for the applicable grade. In addition, as required in paragraph 4 and Table 3, the hardness shall be not less than the minimum hardness specified in Table 1 for the applicable grade.

5.2 Surface Hardness—Tests to determine surface hardness conditions shall be conducted on the ends, hexagon flats, or unthreaded shanks which have been prepared by lightly grinding or polishing to insure accurate reproducible readings in accordance with SAE J417. Proper correction factors shall be used when hardness tests are made on curved surfaces, per ASTM E 18.

Depending on the location and individual surface upon which the test is conducted, some increase in hardness above that specified in Table 1, when measured on the Rockwell 30N scale, may occur for reasons other than carburization. To insure that lots of products not considered acceptable for this cause are in fact carburized, the metallographic and hardness checking technique described in SAE J121 shall be used.

In applying the J121 procedure, a difference between Knoop and Rockwell 30N readings by conversion may occur. This difference is disregarded since the primary purpose of the Knoop traverse in J121 is to establish the existence of carburization.

5.3 Proof Load—The proof load test consists of stressing the bolt, screw, stud, or sem with a specified load which the product must with-

TABLE 3 — MECHANICAL TESTING REQUIREMENTS FOR BOLTS, SCREWS, STUDS, AND SEMS

Product	Grade	Specified Min Tensile Strength of Product, lb	Length of Product	Hardness[a]		Tests Conducted Using Full Size Products[a]			Tests Conducted Using Machine Test Specimens[a]			
				Max	Min	Proof Load	Wedge Tensile Strength	Axial Tensile Strength	Yield Strength	Axial Tensile Strength	Elongation	Reduction of Area
Short Bolts and Screws	1, 2, 5, 5.2, 7, 8	All	Less than 3D[b]	*	*	—	—	—	—	—	—	—
Special Head Bolts and Screws[c]	1, 2, 5, 5.2, 7, 8	All	All	*	*	—	—	—	—	—	—	—
Square and Hex Bolts and Screws	1, 2, 5, 5.2, 7, 8	100,000 and less	3D to 8D or 8 in, whichever is greater	*	—	*	*	—	—	—	—	—
			Over 8D or 8 in, whichever is greater, thru and including 12 in	*	—	Option A	*	—	Option B	Option B	Option B	Option B
			Over 12 in	*	—	Option A	Option A	—	Option B	Option B	Option B	Option B
		Over 100,000	3D and longer	*	—	Option A	Option A	—	Option B	Option B	Option B	Option B
All Other Bolts and Screws	1, 2, 5, 5.2, 7, 8	100,000 and less	3D to 8D or 8 in, whichever is greater	*	—	*	—	*	—	—	—	—
			Over 8D or 8 in, whichever is greater	*	—	Option A	—	Option A	Option B	Option B	Option B	Option B
		Over 100,000	3D and longer	*	—	Option A	—	Option A	Option B	Option B	Option B	Option B
Short Studs	1, 2, 4, 5, 8, 8.1	All	Less than 3D	*	*	—	—	—	—	—	—	—
Studs	4	All	3D and longer	*	—	—	—	—	*	*	*	*
All Other Studs	1, 2, 5, 8, 8.1	100,000 and less	3D to 8D or 8 in, whichever is greater	*	—	*	*	—	—	—	—	—
			Over 8D or 8 in, whichever is greater	*	—	Option A	Option A	—	Option B	Option B	Option B	Option B
		Over 100,000	3D and longer	*	—	Option A	Option A	—	Option B	Option B	Option B	Option B
Short Bolts, Screws, and Sems	5.1	All	Less tha 3D	*	*	—	—	—	—	—	—	—
Hex Head Bolts, Screws, and Sems	5.1	All	3D and longer	*	—	*	*	—	—	—	—	—
Other Bolts, Screws, and Sems	5.1	All	3D and longer	*	—	*	—	*	—	—	—	—
Tests to be performed in accordance with paragraph				5.1		5.3	5.5	5.4	5.6			

[a] Asterisks (*) denote mandatory tests. Where options are indicated, all Option A tests (which apply to full size products) or all Option B tests (which apply to machined specimens) shall be performed. Option B tests shall be performed in case arbitration is necessary. Dashes (—) denote tests which are not required.

[b] D equals nominal diameter of the product.

[c] Special head bolts and screws are those with special configurations or with drilled heads which are weaker than the threaded section.

stand without permanent set.

The overall length of the specimen shall be measured between conical or ball centers on the centerline of the specimen, using mating centers on the measuring anvils. The specimen shall be marked so that it can be placed in the measuring fixture in the same position for all measurements. The measurement instrument shall be capable of measurement to 0.0001 in. In the case of sems, the washer shall be removed from the screw prior to assembly in the testing machine. The grips of the testing machine shall be self-aligning to avoid side thrust on the specimen. For bolts, screws, and sems, the specimen shall be assembled in the fixture of the tensile machine so that six complete threads are exposed between the grips. This is obtained by freely running the nut or fixture to the thread runout of the specimen and then unscrewing the specimen six full turns. When proof load testing studs, one end of the stud shall be assembled in a threaded fixture to the thread runout. For studs having unlike threads, this shall be the end with the finer pitch thread. The other end of the stud shall likewise be assembled in a threaded fixture, except it shall be unscrewed six full turns from the thread runout, thus leaving six complete threads exposed between the grips. The bolt, screw, stud, or sem shall then be axially loaded to the proof load specified for the applicable size, thread series, and grade in Table 5, the load retained for a period of 10 s, the load removed, and the overall length again measured. The speed of testing, as determined with a free running cross head, shall not exceed 0.12 in/min.

To meet the requirements of paragraph 4, the length of the bolt, screw, stud, or sem after loading shall be the same as before loading within a tolerance of ±0.0005 in allowed for measurement error.

Variables, such as straightness and thread alignment (plus measurement error), may result in apparent elongation of the fasteners when the proof load is initially applied. In such cases, the fastener may be retested using a 3% greater load, and may be considered satisfactory if the length after this loading is the same as before this loading (within the 0.0005 in tolerance for measurement error).

TABLE 4 — TENSILE TEST WEDGE ANGLES

Product	Grade	Nominal Size of Product, in	Wedge Angle, deg
Bolts and Screws	1, 2	1/4 thru 1	10
		Over 1 to 1-1/2	6
	5, 5.2, 7, 8[a]	1/4 thru 1	10
	5, 7, 8[a]	Over 1 to 1-1/2	6
Hex Head Bolts, Screws and Sems	5.1	No. 6 thru 3/8	6
Studs	1, 2, 5, 8, 8.1	1/4 thru 3/4	6
		Over 3/4 to 1-1/2	4

[a] For Grades 5, 5.2, 7, and 8 bolts and screws which are threaded 1 dia and closer to the underside of head, wedge angle shall be 6 deg for sizes 1/4 through 3/4 in, and 4 deg for sizes over 3/4 in.

5.4 Axial Tensile Strength—Following proof load testing, the same bolt, screw, stud, or sem shall be reassembled in the testing machine with six complete threads exposed between the grips and axial loading applied until failure. The grips of the testing machine shall be self-aligning to avoid side thrust on the specimen. Typical fixturing is illustrated in Fig. 1. The speed of testing, as determined with a free running cross head, shall not exceed 1 in/min.

To meet the requirements of paragraph 4, the bolt, screw, stud, or sem shall fracture at a load not less than the minimum tensile strength specified for the applicable size, thread series, and grade in Table 5. In addition, for bolts, screws, and sems, the fracture shall occur in the body or threaded section with no failure at the junction of the head and shank.

5.5 Wedge Tensile Strength

5.4.1 BOLTS AND SCREWS—Following proof load testing, the same bolt or screw shall be assembled with a wedge inserted under the head, as

TABLE 5 — PROOF LOAD AND TENSILE STRENGTH REQUIREMENTS[a]

Nominal Dia of Product and Threads per in	Stress Area, sq in	Grade 1		Grade 2		Grades 5 and 5.2[b]		Grade 5.1		Grade 7		Grades 8 and 8.1	
		Proof Load, lb	Tensile Strength Min, lb	Proof Load, lb	Tensile Strength Min, lb	Proof Load, lb	Tensile Strength Min, lb	Proof Load, lb	Tensile Strength Min, lb	Proof Load, lb	Tensile Strength Min, lb	Proof Load, lb	Tensile Strength Min, lb
Coarse Thread Series—UNC													
No. 6—32	0.00909	—	—	—	—	—	—	750	1,100	—	—	—	—
8—32	0.0140	—	—	—	—	—	—	1,200	1,700	—	—	—	—
10—24	0.0175	—	—	—	—	—	—	1,500	2,100	—	—	—	—
12—24	0.0242	—	—	—	—	—	—	2,050	2,900	—	—	—	—
1/4 —20	0.0318	1,050	1,900	1,750	2,350	2,700	3,800	2,700	3,800	3,350	4,250	3,800	4,750
5/16—18	0.0524	1,750	3,150	2,900	3,900	4,450	6,300	4,450	6,300	5,500	6,950	6,300	7,850
3/8 —16	0.0775	2,550	4,650	4,250	5,750	6,600	9,300	6,600	9,300	8,150	10,300	9,300	11,600
7/16—14	0.1063	3,500	6,400	5,850	7,850	9,050	12,800	—	—	11,200	14,100	12,800	15,900
1/2 —13	0.1419	4,700	8,500	7,800	10,500	12,100	17,000	—	—	14,900	18,900	17,000	21,300
9/16—12	0.182	6,000	10,900	10,000	13,500	15,500	21,800	—	—	19,100	24,200	21,800	27,300
5/8 —11	0.226	7,450	13,600	12,400	16,700	19,200	27,100	—	—	23,700	30,100	27,100	33,900
3/4 —10	0.334	11,000	20,000	18,400	24,700	28,400	40,100	—	—	35,100	44,400	40,100	50,100
7/8 — 9	0.462	15,200	27,700	15,200	27,700	39,300	55,400	—	—	48,500	61,400	55,400	69,300
1 — 8	0.606	20,000	36,400	20,000	36,400	51,500	72,700	—	—	63,600	80,600	72,700	90,900
1-1/8 — 7	0.763	25,200	45,800	25,200	45,800	56,500	80,100	—	—	80,100	101,500	91,600	114,400
1-1/4 — 7	0.969	32,000	58,100	32,000	58,100	71,700	101,700	—	—	101,700	127,700	116,300	145,400
1-3/8 — 6	1.155	38,100	69,300	38,100	69,300	85,500	121,300	—	—	121,300	153,600	138,600	173,200
1-1/2 — 6	1.405	46,400	84,300	46,400	84,300	104,000	147,500	—	—	147,500	186,900	168,600	210,800
Fine Thread Series—UNF													
No. 6—40	0.01015	—	—	—	—	—	—	850	1,200	—	—	—	—
8—36	0.01474	—	—	—	—	—	—	1,250	1,750	—	—	—	—
10—32	0.0200	—	—	—	—	—	—	1,700	2,400	—	—	—	—
12—28	0.0258	—	—	—	—	—	—	2,200	3,100	—	—	—	—
1/4 —28	0.0364	1,200	2,200	2,000	2,700	3,100	4,350	3,100	4,350	3,800	4,850	4,350	5,450
5/16—24	0.0580	1,900	3,500	3,200	4,300	4,900	6,950	4,900	6,950	6,100	7,700	6,950	8,700
3/8 —24	0.0878	2,900	5,250	4,800	6,500	7,450	10,500	7,450	10,500	9,200	11,700	10,500	13,200
7/16—20	0.1187	3,900	7,100	6,550	8,800	10,100	14,200	—	—	12,500	15,800	14,200	17,800
1/2 —20	0.1599	5,300	9,600	8,800	11,800	13,600	19,200	—	—	16,800	21,300	19,200	24,000
9/16—18	0.203	6,700	12,200	11,200	15,000	17,300	24,400	—	—	21,300	27,000	24,400	30,400
5/8 —18	0.256	8,450	15,400	14,100	18,900	21,800	30,700	—	—	26,900	34,000	30,700	38,400
3/4 —16	0.373	12,300	22,400	20,500	27,600	31,700	44,800	—	—	39,200	49,600	44,800	56,000
7/8 —14	0.509	16,800	30,500	16,800	30,500	43,300	61,100	—	—	53,400	67,700	61,100	76,400
1 —12	0.663	21,900	39,800	21,900	39,800	56,400	79,600	—	—	69,600	88,200	79,600	99,400
1 —14 uns	0.679	22,400	40,700	22,400	40,700	57,700	81,500	—	—	71,300	90,300	81,500	101,900
1-1/8 —12	0.856	28,200	51,400	28,200	51,400	63,300	89,900	—	—	89,900	113,800	102,700	128,400
1-1/4 —12	1.073	35,400	64,400	35,400	64,400	79,400	112,700	—	—	112,700	142,700	128,800	161,000
1-3/8 —12	1.315	43,400	78,900	43,400	78,900	97,300	138,100	—	—	138,100	174,900	157,800	197,200
1-1/2 —12	1.581	52,200	94,900	52,200	94,900	117,000	166,000	—	—	166,000	210,300	189,700	237,200

[a] Proof loads and tensile strengths are computed by multiplying the proof load stresses and tensile strengths stresses given in Table 1 by the stress area of the thread.

The stress area of sizes and thread series not included in Table 5 may be computed from the formula:

$$A_s = 0.7854 \left[D - \frac{0.9743}{n} \right]^2$$

where D equals nominal diameter in inch, and n equals threads per inch.

[b] Grade 5.2 applicable to sizes 1/4 through 1 in.

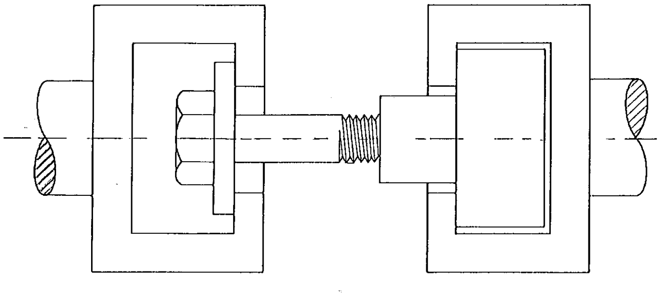
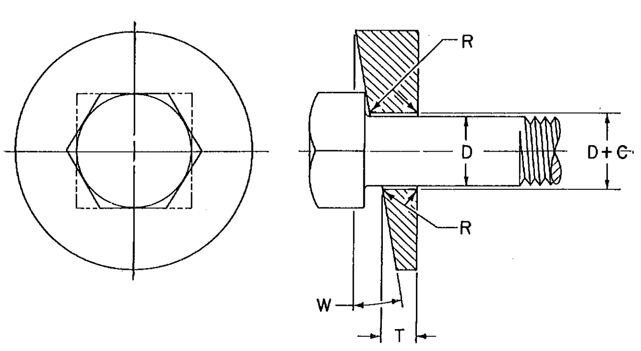


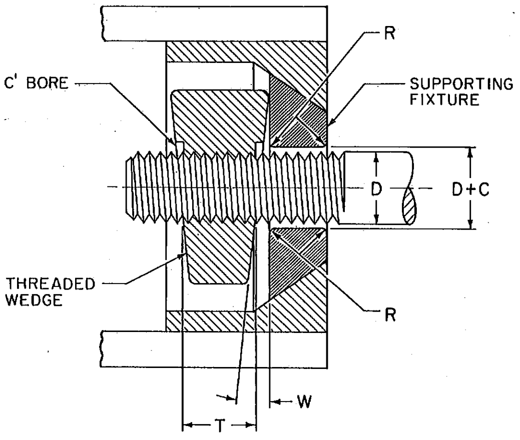
FIG. 1—TENSILE TESTING OF FULL SIZE BOLT OR SCREW



C = CLEARANCE OF HOLE (SEE PARA. 5.4.1.)
D = DIAMETER OF BOLT OR SCREW
R = RADIUS OR CHAMFER (SEE PARA. 5.4.1.)
T = THICKNESS OF WEDGE AT THIN SIDE OF HOLE EQUALS ONE HALF DIAMETER OF BOLT OR SCREW
W = WEDGE ANGLE (SEE TABLE 4)

FIG. 2—WEDGE TEST DETAILS—BOLTS AND SCREWS

illustrated in Fig. 2, installed in the testing machine and tensile tested to failure, as described in paragraph 5.3. The angle of the wedge for the bolt or screw size and grade is specified in Table 4. The wedge shall be so placed that no corner of the square or hexagon bolt or screw head takes the bearing load; that is, a flat of the head shall be aligned with the direction of uniform thickness of the wedge. The wedge shall have a minimum hardness of Rockwell C45. The wedge shall have a thickness of one-half the bolt or screw diameter measured at the thin side of the hole. The hole in the wedge shall have the following clearance over the nominal size of the bolt or screw, and its top and bottom edges shall be rounded or chamfered 45 deg to the fol-



C = CLEARANCE OF HOLE (SEE PARA. 5.4.1.)
D = DIAMETER OF STUD
R = RADIUS OR CHAMFER (SEE PARA. 5.4.1.)
T = D PLUS DEPTH OF COUNTERBORE
W = WEDGE ANGLE (SEE TABLE 4)

FIG. 3—WEDGE TEST DETAILS—STUDS

TABLE 6—DIMENSIONS OF MACHINED TEST SPECIMENS (SEE FIG. 5 AND PARAGRAPH 5.5)

Nominal Dia of Product	Gage Length G	Dia Parallel Section, D	Length Parallel Section, Min, A	Fillet Radius, Min, R
3/4 thru 1-1/2	2.000±0.005	0.500±0.010	2.25	0.38[a]
1/4 thru 5/8	1.400±0.005	0.350±0.007	1.75	0.25
	1.000±0.005	0.250±0.005	1.25	0.19

[a] Minimum radius recommended 0.38 in; 0.12 minimum permitted.

lowing dimensions:

Nominal Bolt or Screw Size, in	Clearance in Hole, in	Radius or Depth of Chamfer in
No. 6 thru 12	0.020	0.020
1/4 thru 1/2	0.030	0.030
9/16 thru 3/4	0.050	0.060
7/8 and 1	0.060	0.060
1-1/8 and 1-1/4	0.060	0.125
1-3/8 and 1-1/2	0.094	0.125

The wedge may be either circular or square. The recommended outside dimension of the wedge is 1¾ in for bolt and screw sizes ¼ through ¾ in, and 3½ in for bolt and screw sizes ⅞ to 1½ in.

To meet the requirements of paragraph 4, the bolt or screw shall fracture at a load not less than the minimum tensile strength specified for the applicable size, thread series, and grade in Table 5. In addition, the fracture shall occur in the body or threaded section with no failure at the junction of head and shank.

5.4.2 Studs—Following proof load testing, one end of the same stud shall be assembled in a threaded fixture to the thread runout. For studs having unlike threads, this shall be the end with the finer pitch thread. The other end of the stud shall be assembled in a threaded wedge to the runout and then unscrewed six full turns, thus leaving six complete threads exposed between the grips, as illustrated in Fig. 3. The angle of the wedge for the stud size and grade shall be as specified in Table 4. The stud shall be assembled in the testing machine and tensile tested to failure, as described in paragraph 5.3.

The minimum hardness of the threaded wedge shall be Rockwell C45. The length of the threaded section of the wedge shall be equal to the diameter of the stud. To facilitate removal of the broken stud, the wedge shall be counterbored. The thickness of the wedge at the thin side of the hole shall equal the diameter of the stud plus the depth of counterbore. The thread in the wedge shall have Class 3B tolerances, except when testing studs having an interference fit thread, in which case the wedge shall be threaded to provide a finger free fit.

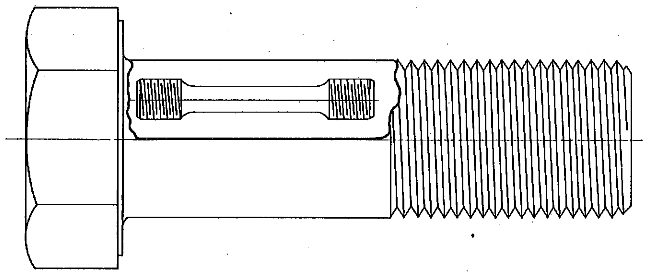


FIG. 4—LOCATION OF STANDARD ROUND 2 IN. GAGE LENGTH TENSILE TEST SPECIMEN WHEN TURNED FROM LARGE SIZE BOLTS OR SCREWS

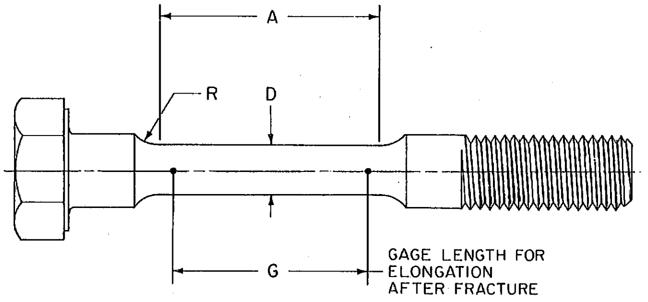


FIG. 5—TENSILE TEST SPECIMEN FOR BOLTS OR SCREWS WITH TURNED DOWN SHANK

The supporting fixture, as shown in Fig. 3, shall have a hole clearance over the nominal size of the stud, and shall have its top and bottom edges rounded or chamfered to the same limits specified for the hardened wedge in paragraph 5.4.1.

To meet the requirements of paragraph 4, the stud shall fracture at a load not less than the minimum tensile strength specified for the applicable size, thread series, and grade in Table 5.

5.6 Testing of Machined Test Specimens—Where bolts, screws, and studs cannot be tested in full size for proof load and tensile strength requirements, tests shall be conducted using test specimens machined from the bolt, screw, or stud.

For 1½ in diameter bolts, screws, and studs, a standard 0.500 in round 2 in gage length test specimen shall be turned from the bolt, screw, or stud with the axis of the specimen located midway between the center and outside surface of the bolt, screw, or stud shank, as shown in Fig. 4. Bolts, screws, and studs ¾ through 1⅜ in diameter shall have their shanks machined to the dimensions of a standard 0.500 in round 2 in gage length test specimen concentric with the axis of the bolt, screw, or stud, leaving the bolt or screw head and threaded sections intact, as shown in Fig. 5. Bolts, screws, and studs ¼ through ⅝ in diameter shall have their shanks machined to subsize specimens having dimensions shown in Fig. 5 and Table 6.

The test specimen shall be tensile tested as described in paragraph 5.3; and the yield strength, tensile strength, elongation, and reduction of area determined.

To meet the requirements of paragraph 4, the test specimen must have a yield strength, tensile strength, elongation, and reduction of area equal to or greater than the values for these properties specified for the applicable product size and grade in Table 1.

6. Marking—Bolts, screws, and hex head sems shall be marked with the grade identification symbol shown in Table 1. In addition, bolts and screws shall be marked with the manufacturer's identification symbol. Markings shall be located on the top of the head, and may be either raised or depressed, at option of the manufacturer.

Studs need not be marked.

7. Testing Requirements

7.1 Manufacturer's Responsibility—During the manufacture of products to the requirements of this specification, the manufacturer shall make periodic tests to ensure that the properties of the product are being maintained within specified limits. Such tests shall be conducted in accordance with a sampling plan, preferably the sampling plan given in paragraph 7.3, and the test results shall be recorded in a test report. When requested in writing by the purchaser, the manufacturer shall furnish a copy of the test report certified to be a report of the results of the last completed set of tests for the specific type, size, length, and grade of product.

Additional tests of products in individual shipments are not normally contemplated. Unless otherwise agreed at time of original inquiry and purchase order, individual heats of steel need not be identified in the finished product.

7.2 **Purchaser's Options**—If the purchaser requires that additional tests be performed by the manufacturer to determine that the properties of products in an individual shipment are within specified limits, or if the purchaser requires that a sampling plan different from that given in paragraph 7.3 shall be used when determining the acceptability of a lot, or shipment, of products, the purchaser shall specify the complete testing requirements, including sampling plan and basis of acceptance, in the original inquiry and purchase order.

7.3 **General**—An acceptable sampling plan is outlined below:

Number of Pieces in Lot	Minimum Number of Specimens To Be Tested
50 and under	2
51 to 500	3
501 to 35,000	5
35,001 and over	8

A lot, for purposes of selecting test specimens, shall consist of all products offered for inspection and testing at one time that are of the same type, grade, size, length, and thread series and are manufactured essentially at one time and under the same process conditions.

The same test specimen may be used for different tests wherever practical.

When tested in accordance with this sampling plan, a lot shall be subject to rejection if any of the test specimens fail to meet the applicable test requirements. If the failure of a test specimen is due to improper preparation of the specimen or to incorrect testing technique, the specimen shall be discarded and another specimen substituted.

APPENDIX

(Relative to 150,000 psi tensile bolts and screws produced from low carbon martensite steels and designated as Grade 8.2)

A.1.Preface—Coverage for 150,000 psi tensile bolts and screws produced from low carbon martensite steels is included in SAE J429 because several large steel and bolt producers and users have reported highly favorable results with such products over a period of more than three years. This coverage is designated by a separate grade number (Grade 8.2) to distinguish such fasteners from Grade 8 made of medium carbon and medium carbon alloy steels. It has been placed in an appendix until additional experience has been obtained by both users and producers.

Limited data available concerning room temperature ductility and low temperature impact characteristics indicate that fasteners made to Grade 8.2 requirements may have advantages compared to alloy steels historically used for Grade 8 fasteners.

Heat treatment control for elements such as decarburization or carburization and quench medium heat transfer are more critical for Grade 8.2 than for Grade 8 steels. Thus, more attention should be given to verification of the use of proved practices. (It is suggested that users initially require details of heat treatment practices from the fastener producer until a broad spectrum of suppliers are familiar with the closer controls necessary.)

Users should recognize the difference in stress relaxation characteristics of various steels between the temperature range of 650 F, minimum, specified for Grade 8.2 and 800 F, minimum, specified for Grade 8, when considering bolts and screws that may be exposed to such temperature range. The data available on elevated temperature properties of Grade 8.2 indicates that performance testing is desirable in applications where the operating temperature exceeds 500 F (as may also be the case with Grade 8 fasteners).

The requirements stated, herein, limit the use of steels to those which have been used on a production basis with highly favorable results. There is much evidence that other steels are satisfactory also, but these are excluded from the standard until more widespread experience is had with them.

A.2 Requirements

Grade Designation	8.2
Applicable to	Bolts and screws 1/4 thru 1 in nominal size
Mechanical Requirements	
Full size bolts and screws	Same as Grade 8 (Table 1)
Machined test specimens	Same as Grade 8 (Table 1)
Core hardness, Rockwell	C35-42
Surface hardness, Rockwell 30N	61 max
Mechanical Testing Requirements	Same as Grade 8 (bolts and screws)
Grade Identification Marking	Six radial lines, 30 deg apart
Steel Chemical Composition	Carbon, 0.15-0.25 Manganese, 0.74 min Phosphorous, 0.048 max Sulfur, 0.058 max Boron, 0.0005 min
Steel Characteristics	Low carbon martensite, fine grain, fully killed, and hardenability that will produce a minimum hardness of Rockwell C38 at the center of the threaded section one nominal diameter from end of bolt or screw after quenching
Heading Practice	Same as Grade 8 (paragraph 3.2)
Threading Practice	Same as Grade 8 (paragraph 3.2)
Heat Treatment Practice	Grade 8.2 bolts shall be fully austenitized, quenched in oil or water, and tempered at a minimum temperature of 650 F (340 C)
Decarburization Limits	Same as Grade 8 (paragraph 3.5)